Crawford School of Economics and Government

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Rationing and Length: The impact of water supply interruptions on residential users

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OUTLINE

1. Aims and motivation
2. Drought in Seville
3. Methodology
4. Empirical analysis

   (I) Residential water demand function

   (II) Welfare and rationing
5. Concluding remarks

AIMS AND MOTIVATION

- **Aims**:
  - Which interruption length is preferred: short or long?
  - Comparing several rationing methods applied during drought periods (welfare analysis):
    - Water supply interruptions
    - Water price increases

- **Motivation:**
  - Residential water use:
    - Usually, the main urban water use
    - Urban users as a priority
  - Improvement of previous methodologies
  - Management of urban water demands
  - Water resource value (EWF)

DROUGHT IN SEVILLE

- **Analyzed drought period** : 1992-1996.
- **Water firm (EMASESA) initiatives:**
  - Demand
    - ✓Information campaignes
    - ✓Rationing:
      - **Water supply interruption (up to 12 hours per day)**
  - Supply
    - ✓Firm reorganization
    - ✓New supply sources
- **During drought, we observe a significant reduction of water resource quality**

METHODOLOGY

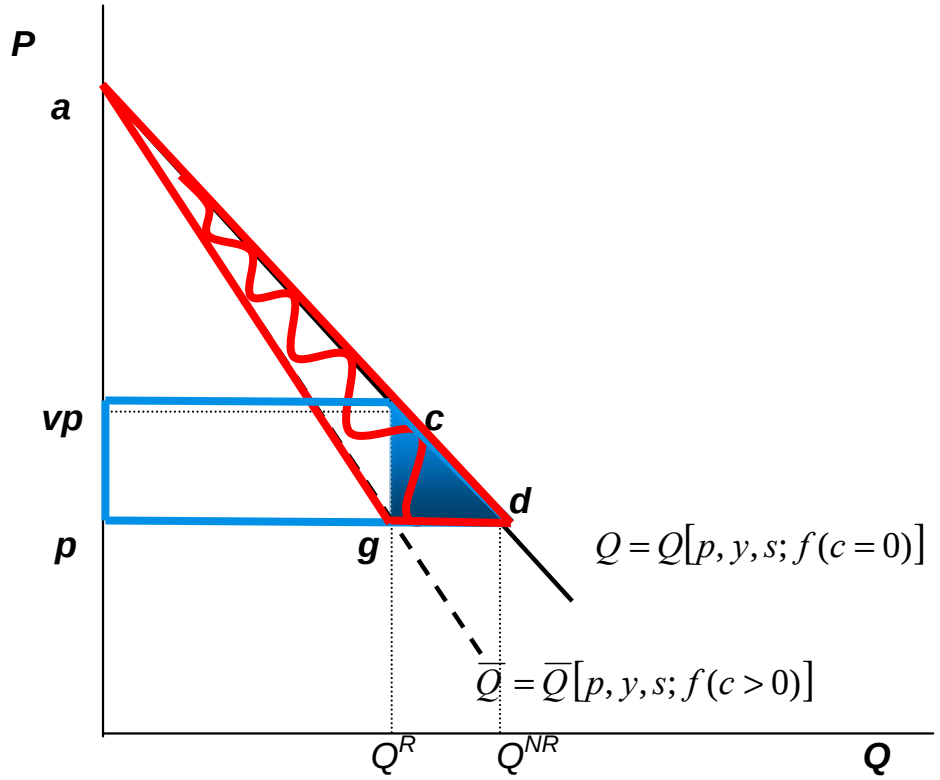
- Demand function with two components:

$$Q = Q[p,y,s;f(c,y)] = q(p,y,s)\cdot f(c,y)$$

- Welfare measurement: surplus (inconsistency using compensated variation: Roibas et al. 2007)
  - Supply interruption:
    - Proportional rationing assumption (Tirole, 1990)
  - Prices:
    - Efficient rationing assumption
    - Virtual prices (Tobin y Houthakker, 1951)

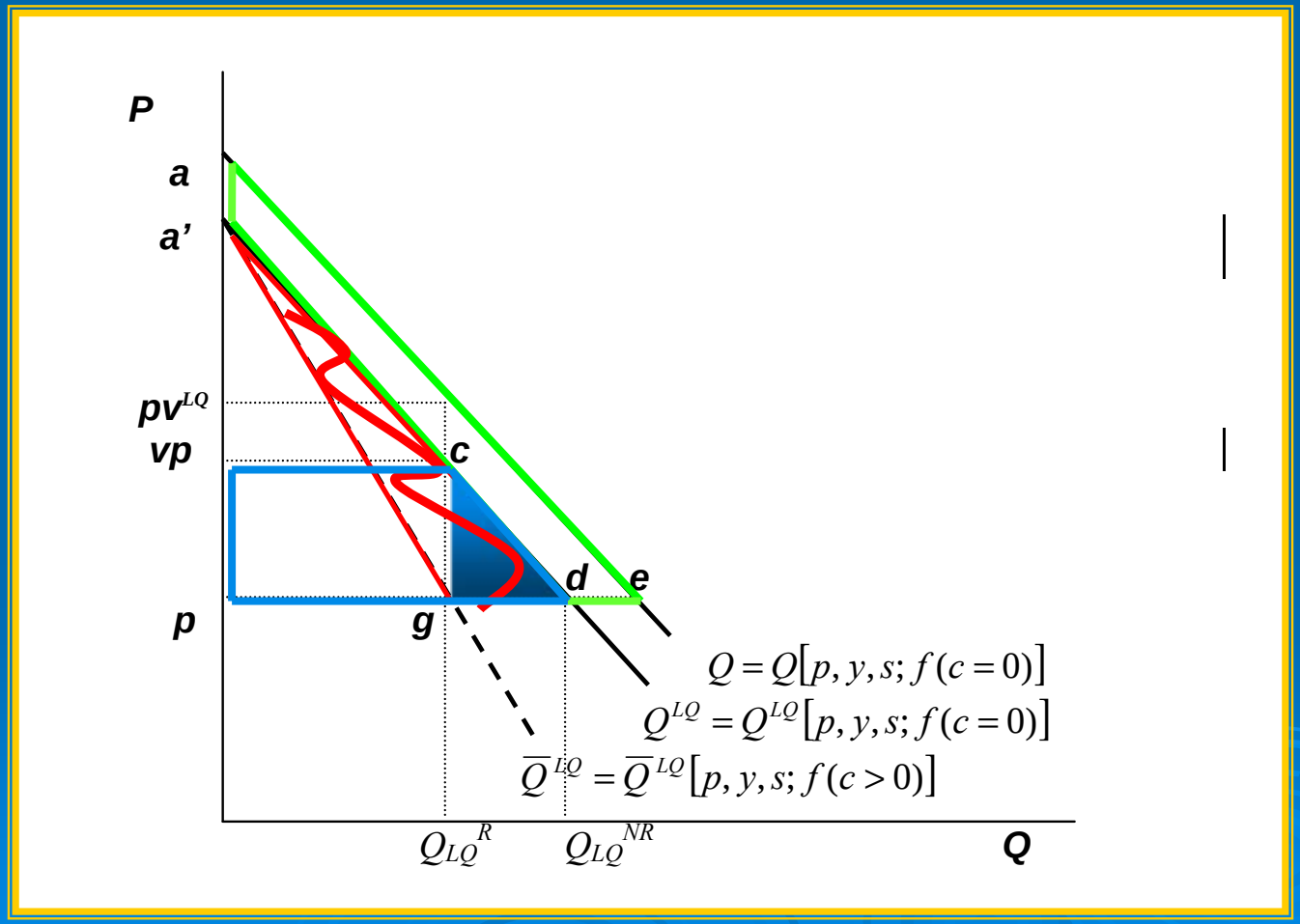
METHODOLOGY

Scenario 1: “Good” water resource/service quality



METHODOLOGY

Scenario 2: "Bad" water resource quality



EMPIRICAL ANALYSIS

$$Q_{it} = \left[\beta_0 + \beta_1 p_{it-2} + \beta_2 y_i + \beta_3 temp_t + \beta_4 nper_i + \beta_5 qual_t\right] \left[1 + d_h\left(\alpha_0 + \alpha_1 c_t^s + \alpha_2 c_t^l + \alpha_3 y_i\right)\right]$$

DEPENDENT VARIABLE	Q_{it}: household water consumption per quarter
INDEPENDENT VARIABLES	
PRICE	P_{it-2}: two-lagged average price
INTERRUPTION VARIABLES	c^s_t: Total hours of interruption, when (marginal) cuts are equal or lower than 6 hours per day (“short cut”) c^l_t: Total hours of interruption, when (marginal) cuts are higher than 6 hours per day (“long cut”)
QUALITY	$qual_t$: dummy: 1= low quality; 0=otherwise
SOCIOECONOMIC VARIABLES	y_i: income index $nper_i$: number of people per household
CLIMATIC VARIABLES	$temp_t$: average of maximun temperatures

EMPIRICAL ANALYSIS

- **Panel data:**
  - **208 Sevillian households (individual metering)**
  - **Period: 1991(4)-2000(3)**

Variable	Units	Mean	Stan. Dev.	Max.	Min.
Q	m^3	108.69	150.48	527.84	1.90
p	*Euros/*m^3	1.43	0.37	2.22	0.85
y	*Euros/household*	2,426.73	471.06	3,693.25	1,652.24
temp	*Celsius Degrees*	25.54	5.32	32.6	18.1
n	*Persons/House*	3.78	2.11	11.00	1.00
c^{day}	*Hours: Minutes*	4:50	2:03	7:00	0:40

EMPIRICAL ANALYSIS

Residential water demand function: results

Parameter	Coeficient
α_0	-0.323075 ***
$\alpha_1 (c^s)$	-0.000350 ***
$\alpha_2 (c^l)$	-0.000170 ***
$\alpha_3 (y)$	0.000085 ***
β_0	-103.0780 ***
$\beta_1 (p)$	-31.5009 ***
$\beta_2 (y)$	0.0033
$\beta_3 (temp)$	0.8969 ***
$\beta_4 (nper)$	62.7401 ***
$\beta_5 (qual)$	-22.7933 ***
R^2	**0.6921**

EMPIRICAL ANALYSIS

Welfare and rationing

	QUAL=0		QUAL=1	
	$c^{s(=223)}$	$c^{l(=545)}$	$c^{s(223)}$	$c^{l=(545)}$
Q^{NR}	120.02		97.23	
$\downarrow Q$	-23.28	-25.00	-18.86	-20.25
p	1.43		1.43	
vp	2.17	2.23	2.03	2.07
vp^{q}	---	---	2.75	2.80
$\downarrow W^{c}$	44.34	47.62	29.10	31.25
$\downarrow W^{p}$	8.60	9.92	5.64	6.51
$\downarrow W^{LQ}$	---	---	78.60	

CONCLUDING REMARKS

- Methodological contribution:
  - Residential demand function
  - Analyzing several rationing systems
  - Virtual prices: information about willigness to pay for water without restrictions.

- Short interruptions more efective/efficient than long interruptions:
  - Short interruptions are preferred to achieve the targeted reduction in consumption, minimizing the total time of interruption.
  - Useful information to design water policies during drought periods.

Thank you for your attention